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<u>*Proprietary Notice*</u>
This letter forwards GNF proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 1, the balance of this letter may be considered non-proprietary.

MFN 06-295
Supplement 1

Docket No. 52-010

November 15, 2006

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC Request for Additional Information Letter No. 49 Related to ESBWR Design Certification Application – Nuclear Design – RAI Number 21.6-54**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter. The attached history dependent void fraction files to Enclosure 1 are entirely proprietary. If a non proprietary version were provided, the files would be blank. Thus, a non proprietary version of the history dependent void fraction files is not provided.

Enclosure 1 contains GNF proprietary information as defined by 10 CFR 2.390. GNF customarily maintains this information in confidence and withholds it from public disclosure. The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GNF. GE hereby requests that the information of Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17. A non proprietary version is provided in Enclosure 2.

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If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

Reference:

1. MFN 06-276, Letter from U. S. Nuclear Regulatory Commission to Mr. David H. Hinds, *Request for Additional Information Letter No. 49 Related to ESBWR Design Certification Application,* August 8, 2006

Enclosures:

1. MFN 06-295, Supplement 1 - Response to Portion of NRC Request for Additional Information Letter No. 49 Related to ESBWR Design Certification Application – Nuclear Design – RAI Number 21.6-54 – GNF Proprietary Information
2. MFN 06-295, Supplement 1 - Response to Portion of NRC Request for Additional Information Letter No. 49 Related to ESBWR Design Certification Application – Nuclear Design – RAI Number 21.6-54 – Non Proprietary Version
3. Affidavit – Jens G. M. Andersen – dated November 15, 2006

cc:	AE Cubbage	USNRC (with enclosures)
	AA Lingenfelter	GNF/Wilmington (w/o enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRF	0059-9374

ENCLOSURE 2

MFN 06-295, Supplement 1

Response to Portion of NRC Request for

Additional Information Letter No. 49 Related to

ESBWR Design Certification Application

Nuclear Design

RAI Number 21.6-54

Non Proprietary Version

NRC RAI 21.6-54

Provide the following design information related to NEDC-33239P, "GE14 for ESBWR Nuclear Design Report," February 2006, for the staff's independent calculations:

- *A.* *PANACEA 3D exposure data, fuel composition, and void history data at BOC, EOC and MOC*
- *B.* *Hot Full Power (HFP) temperature of the fuel (UO2), clad, and coolant*
- *C.* *The size of the perturbation for temperature and void used to calculate Doppler, moderator and void coefficients*
- *D.* *Fuel density for UO2 and UO2+Gad*
- *E.* *Bundle structural materials and associated densities*
- *F.* *Dimensions, compositions, densities and typical operating temperatures for the control rods*
- *G.* *Dimensions for the letters in diagram in Figure 1-1 for bundles 90018 and 90019*
- *H.* *Additional information defining exactly what is meant by the terms "shutdown margin" and "control rod worth"*
- *I.* *Additional fission rate distribution and power distribution for lattices 81802 and 81902 for higher exposures (5, 15, 30, 45, and 60 Gwd/ST)*
- *J.* *Are the local peaking values presented in Figure 3-7 through Figure 3-13 based on fission rate or deposited energy (i.e. with gamma energy redistribution)?*

GE Response

Original Response

Responses to each of the itemized requests follow. These responses do not result in DCD changes.

A. Panacea 3D nodal exposures, nodal void history, and nodal powers for BOC, MOC, and EOC are provided in the following Excel Spreadsheet files. For each file there is a tab representing an axial elevation. Slice 1 represents the bottom of the core. Slice 25 represents the top of the core. NOTE: The entire contents of the attached files are proprietary.

Cycle Exposure	Data Filename
3D Nodal Exposures	
BOC (0 MWd/ST)	3D_Nodal_Exposure_BOC.xls
MOC (8000 MWd/ST)	3D_Nodal_Exposure_MOC.xls
EOC (16772 MWd/ST)	3D_Nodal_Exposure_EOC.xls
3D Nodal Void History	
BOC (0 MWd/ST)	3D_Nodal_Void_Hist_BOC.xls
MOC (8000 MWd/ST)	3D_Nodal_Void_Hist_MOC.xls
EOC (16772 MWd/ST)	3D_Nodal_Void_Hist_EOC.xls
3D Nodal Powers	
BOC (0 MWd/ST)	3D_Nodal_Power_BOC.xls
MOC (8000 MWd/ST)	3D_Nodal_Power_MOC.xls
EOC (16772 MWd/ST)	3D_Nodal_Power_EOC.xls

Fuel composition of the DCD equilibrium design can be found from a combination of tables and figures in reference NEDC-33239P, "GE14 for ESBWR Nuclear Design Report". Figure 3-1 and Figure 3-4 provide the lattice and axial elevations of both of the bundle designs. Figure 3-2 and Figure 3-5 provide the corresponding rod definitions and elevations of enrichment changes. Figure 3-25 and Figure 3-26 provide the loading pattern and BOC bundle average exposures for the two different bundle designs.

B. Hot Full Power (HFP) temperature of the fuel (UO_2), clad, and coolant

Fuel, operating	[[ ]]	
Coolant	559K	
Clad	[[ ]]	(varies with fuel temperature in HELIOS model)
Other Structure	[[ ]]	(for lattice physics calculations)
Doppler temperature	[[ ]]	

C. The elevated temperature for Doppler calculations is 1500°C. Because the nominal reference temperature is 475°C, the delta Doppler perturbation is 1025°C.

The moderator temperature calculations were performed at temperatures 20°C, 60°C, 100°C, 160°C, 220°C, and 286°C. Results of these calculations can be found in Table 3-53 and Table 3-54 of reference NEDC-33239P, "GE14 for ESBWR Nuclear Design Report".

Void coefficient calculations were performed at temperatures 100°C, 160°C, 220°C, and 286°C with a core wide void perturbation of 5% voids. Results of these calculations can be found in Table 3-55 and Table 3-56 of reference NEDC-33239P, “GE14 for ESBWR Nuclear Design Report”.

D. Fuel densities

The NRC calculation for the fuel density for the Gd pins is for the UO_2 only. The density in the NRC's spreadsheet does not include the density of the gadolinia. It is a partial density for UO_2. In the following output, the density for gadolinia-bearing fuel pins includes the mass of the gadolinia.

Fuel Densities (from data provided in Figures 3-2 and 3-3 of NEDC-33239P)

Natural uranium (0.71 wt%)	[[	g/cm³	
Enriched uranium (2.4-4.9 wt%)		g/cm³	
Enriched uranium with Gd (4.4, 4.9 wt%)	]]	g/cm³	(includes fuel and Gd_2O_3)

E. Material densities are provided below.

Densities
zircaloy 0.237 lb/in^3
Stainless steel 0.290 lb/in^3
Alloy X-750 0.300 lb/in^3
Water at 70 degF 0.0361 lb/in^3

F. Dimensions, compositions, densities and typical operating temperatures for the control rods are provided below.

Dimensions
The following figure is Figure 1-1 from NEDC-33239P. The dimensions with respect to the nomenclature:
K = 12.45 cm, ½ span of control rod.
J = 3.937 cm, central support span (i.e. tie rod span).
L = 0.8331 cm, control rod wing thickness
T = 0.1143 cm, sheath thickness
Y = 0.5588 cm, absorber tube outer diameter
V = 0.06858 cm, absorber tube thickness
R1 = 0.0762 cm, central support span radius
R2 = 0.41656 cm, control rod wing tip radius
18 = number of B_4C absorber rods per wing

Compositions
Absorber tube = Stainless Steel
Absorber material = B_4C, 0.198 B-10
Sheath = Stainless Steel
Tie Rod = Stainless Steel

Densities
Absorber tube = 7.93 g/cm^3

Absorber material = 1.7528 g/cm^3
Sheath = 7.93 g/cm^3
Tie Rod = 7.93 g/cm^3

<u>Typical Operating Temperatures</u>
NEDC-33239P does not state the typical operating temperature of the control rod, however the analysis does provide the out of channel moderator temperature:
Hot = 286°C
Cold = 20°C

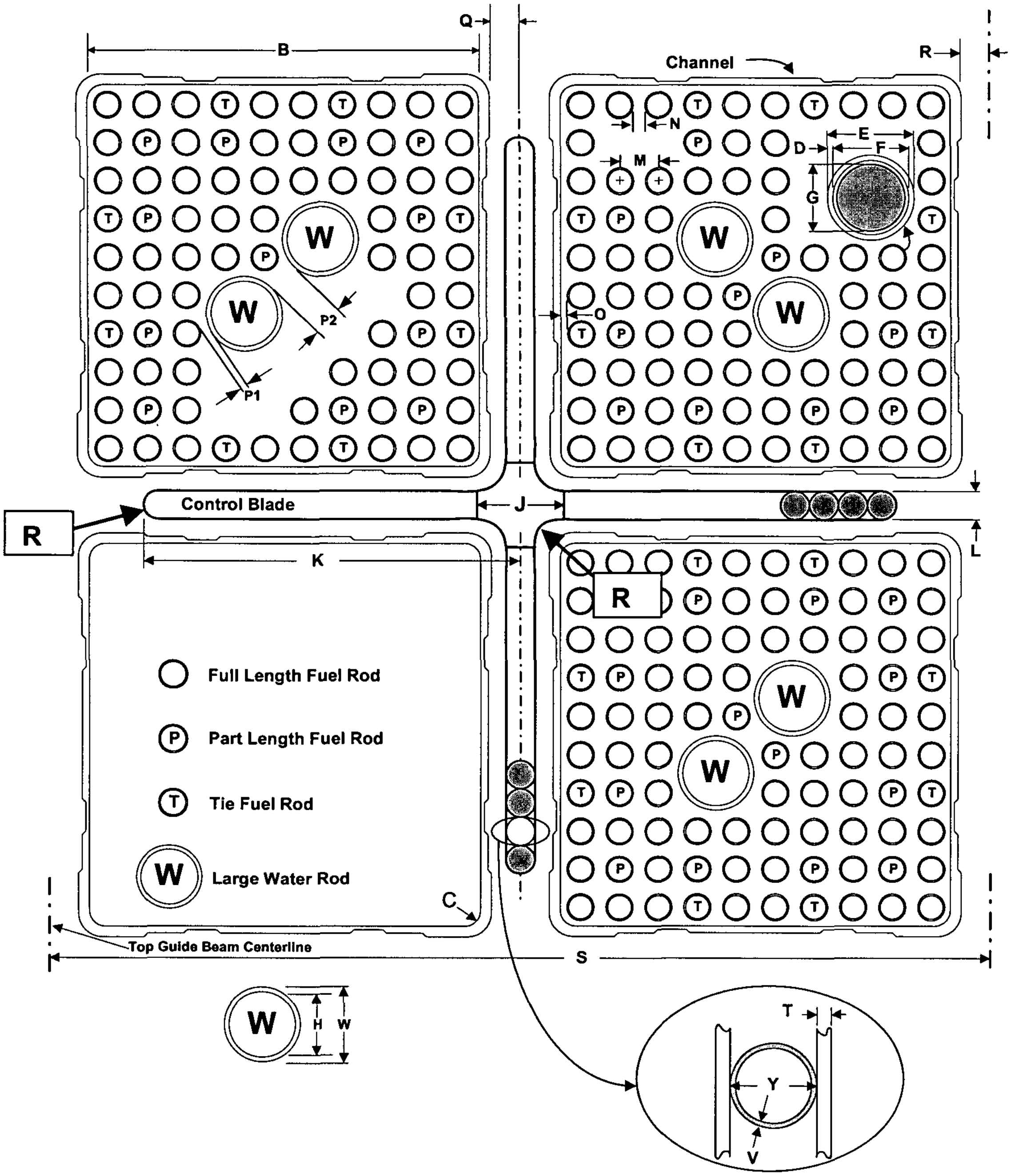

Figure 1-1 from NEDC-33239P

G. See the following table 21.6-54-1. Dimensional data for bundles 90019 and 90018 are taken from NEDC-33239P Figures 3-2, 3-3, 3-5, and 3-6.

Table 21.6-54-1,
Item G, Dimensions Corresponding to Dimensional Designations in Figure 1-1 of NEDC-33239P

GE14 N Lattice Dimensions (MFN 04-063)
Labels correspond to NEDC-33239P

Channel Dimenions		inches	cm	
				Note: HELIOS model has square channel corners
Corner Thickness	TCH	[[		
Median Thickness	TCM			
Small Thickness	TCS			
Long Median Width	WML			
Short Median Width	WMS			
Small Width	WCS			
Large Ramp Width	WRL			
Small Ramp Width	WRS			
Inside Channel Width	B			
Inside Corner Radius	C		]]	
Fuel Rod Dimensions				
Cladding Thickness	D	0.026	0.066	
Cladding OD	E	[[		
Cladding ID	F		]]	
Pellet OD (cold)	G	0.345	0.876	
Water Rod Dimensions				
Rod OD	W	[[		
Rod ID	H		]]	
Control Blade Dimensions				
				Note: HELIOS model based on
Tie Rod Span	J	1.550	3.937	homogenous blade
Blade Length	K	4.902	12.451	
Blade Thickness	L	0.328	0.833	
Blade Sheath Thickness	T	0.045	0.114	
Absorber Tube Wall Thickness	V	0.027	0.069	
Absorber Tube OD	Y	0.220	0.559	
Number of Tubes per Wing		18	18	

Bundle Lattice Dimensions			
Rod Pitch	M	0.510	1.295
Rod-to-rod Gap	N	[[	
Rod to Channel Gap	O		
Water Rod to Fuel Rod Spacing	P1		
Water Rod to Water Rod Spacing	P2		]]
Fuel Cell Dimensions			
1/2 Wide Gap	Q	[[	
1/2 Narrow Gap	R		]]
4-Bundle Pitch	S	12.20	30.988

H. Reference NEDC-33239P commonly refers to "cold shutdown margin". This term refers to the amount of reactivity margin to criticality when the worst rod (or pair of rods) are withdrawn fully from the core. While not identified in reference NEDC-33239P, "control rod worth" is sometimes used to communicate rods with high reactivity control. However, multiple individual rod withdrawals are explicitly modeled in order to find the minimum shutdown margin. The limiting exposure dependent cold shutdown margin can be found in Figure 3-33 of reference NEDC-33239P. Figures 3-34 to 3-36 illustrate the radial values of cold shutdown margin at BOC, MOC, and EOC.

I. The following files provide the fission rate distribution and power distribution for lattices 81802 and 81902 for the requested exposures at 0, 40, and 70 voids. Also included are values at 0 GWd/ST for comparison. NOTE: The entire contents of the attached files are proprietary.

Lattice	**Data Filename**
Fission Rate Distribution	
81802	90018_81802_FRR.txt
81902	90019_81902_FRR.txt
Power Distribution	
81802	90018_81802_RPR.txt
81902	90019_81902_RPR.txt

J. The local peaking values presented in Figure 3-7 through Figure 3-13 are based on deposited energy (with gamma energy redistribution).

Additional information response:

In the response to RAI 21.6-54, GNF provided history dependent relative moderator densities for the ESBWR core design used to support the Design Control Document (DCD). However, it would be more useful to the review team if history dependent void fractions are provided instead. Thus, the history dependent relative moderator densities are converted to history dependent void fractions as described in the following paragraphs.

The relative moderator density can be written as follows:

[[ ]] (1)

where

U_{ijk}:	Relative moderator density of node ijk
UI_{ijk}:	In-Channel relative moderator density of node ijk
UB_{ijk}:	Bypass relative moderator density of node ijk
$VFAT_{ijk}$:	Ratio of in-channel active flow area to total flow area of node ijk
$VFBP_{ijk}$:	Ratio of bypass flow area to total flow area (1-$VFAT_{ikj}$) of node ijk

The in-channel relative moderator density can be expressed as a function of void fraction as follows:

[[ ]] (2)

where

ρ_f:	Density of water at saturation conditions, g/cm^3
ρ_g:	Density of steam at saturation conditions, g/cm^3
α_{ijk}:	Void fraction of node ijk

The bypass relative moderator density is approximated as water at [[ ]] Then, combining equations (1) and (2) and solving for the void fraction yields the following equation:

[[ ]] (3)

The nuclear physics libraries generated with the lattice physics code TGBLA06 are produced with the following densities:

[[

]]

The use of these values is an adequate approximation of the nodal saturation densities since these values are saturation values at approximately [[ ]] psia while the core reference pressure for the ESBWR DCD design is [[ ]] psia.

Therefore, an analogous equation to equation (3) can be written for the history dependent void fraction as follows:

[[ ]] (4)

where

VH_{ijk}: History dependent void fraction

UH_{ijk}: History dependent relative moderator density

Equation (4) is used to calculate the history dependent void fractions. Whenever a negative value is obtained (subcooled region), the history dependent void fraction is set to zero.

The history dependent void fractions are calculated at three cycle exposures: 0.0 MWd/ST, 8000 MWd/ST and 16772 MWd/ST.

The following files contain the history dependent void fractions.

File Name	**Description**
VH_BOC.PDF	History Dependent Void Fraction at BOC
VH_MOC.PDF	History Dependent Void Fraction at MOC
VH_EOC.PDF	History Dependent Void Fraction at EOC

The bottom of each page notes the core slice associated with the history dependent void fraction values. Slice 1 represents the bottom of the core whereas slice [[ ]] represents the top of the core.

This supplemental response to RAI 21.6-54 does not result in any changes to the Design Control Document.

Enclosure 3

MFN 06-295, Supplement 1

Affidavit

Affidavit

I, Jens G. M. Andersen, state as follows:

(1) I am Consulting Engineer, Thermal Hydraulic Methods, Global Nuclear Fuel – Americas, L.L.C. ("GNF-A") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GE letter MFN 06-295, Supplement 1 David H. Hinds to U. S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 49 Related to ESBWR Design Certification Application – Nuclear Design – RAI Number 21.6-54* dated November 15, 2006. The proprietary information in Enclosure 1, *MFN 06-295, Supplement 1 - Response to Portion of NRC Request for Additional Information Letter No. 49 Related to ESBWR Design Certification Application – Nuclear Design – RAI Number 21.6-54,* is delineated by double underlined dark red font text and is enclosed inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. The superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination. The attached history dependent void fraction files to Enclosure 1 are entirely proprietary.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GNF-A relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4) and 2.390(a)(4) for "trade secrets " (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret," within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GNF-A's competitors without license from GNF-A constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GNF-A customer–funded development plans and programs, of potential commercial value to GNF-A;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b., above.

(5) To address the 10 CFR 2.390 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GNF-A, and is in fact so held. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in (6) and (7) following. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GNF-A, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GNF-A. Access to such documents within GNF-A is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GNF-A are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains details of GNF-A's fuel design and licensing methodology.

The development of the methods used in these analyses, along with the testing, development and approval of the supporting methodology was achieved at a significant cost, on the order of several million dollars, to GNF-A or its licensor.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GNF-A's competitive position and foreclose or reduce the availability of profit–making opportunities. The fuel design and licensing methodology is part of GNF-A's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the

extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC–approved methods.

The research, development, engineering, analytical, and NRC review costs comprise a substantial investment of time and money by GNF-A or its licensor.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GNF-A's competitive advantage will be lost if its competitors are able to use the results of the GNF-A experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GNF-A would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GNF-A of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed at Wilmington, North Carolina this 15th day of November 2006.

Jens G. M. Andersen
Global Nuclear Fuels – Americas, LLC